On the Probable Seat of Energy of the Eruption Prominences.

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The enormous rate of ascent occasionally observed in the upheaval of eruption prominences—a most striking instance of which has been carefully discussed by Mr. Proctor in the last number of the *Monthly Notices*—leads us to inquire whether such vast velocities do not betoken something more than mere vertical storms in a gaseous envelope; or why the rate of motion observed in vertical storms or outrushes so greatly exceeds the velocities detected by the spectroscope in the horizontal currents. Further, have we any ground for conjecturing that the prominences are driven upwards by explosions taking place at great depths; or that they are carried outwards by solid masses hurled through the solar envelopes driving before them and followed after in their train by vast eddies of the vapours through which they pass?

When we consider the enormous temperature of the solar envelopes in contact with the photosphere, (estimated even by Zöllner at 68400° C., and calculated by Ericsson at 4035584° Fahr., and by Secchi at over ten million degrees Centigrade), it is at first difficult to conceive of matter existing in the Sun in any other state than that of vapour.

We are, however, so little acquainted with the behaviour of the elements under pressures and temperatures comparable with those which must exist at great depths within the solar globe, that it would be impossible to predict that there is no solid core to the Sun.* Prof. Young, speaking of the great prominence he observed in September last, says, "The whole phenomenon suggested most forcibly the idea of an explosion under the great prominence, acting mainly upwards, but also in all directions outwards." It is not necessary to conceive of chemical change in order that an explosion may take place; some alteration in the physical condition, some passage from the liquid to the gaseous state caused by an alteration of pressure—and involving no chemical change, may be sufficient to cause such an explosion, which, if it took place causing an expansion of the lower and denser vapours, would force them upwards into the outer and lighter envelopes, where, by reason of their greater specific gravity they would be carried further in the resisting medium than the lighter vapours composing the layer above them. Under such a supposition we might expect to find in the newly formed prominences their head or upper part composed of the denser vapours, and the lighter gases lagging behind. This, however, is the reverse of what is found upon the Sun. The prominences have their summits entirely composed of hydrogen, while they are often "gonflé"

* In other words, we cannot predict that the critical temperatures of some of the elements may not be even greater than solar temperature. See Prof. James Thompson's Paper before the British Association, Edinburgh.

with sodium and metallic vapours which have apparently been forced up into them from below, giving a structure such as we might expect to find if a series of layers had been disturbed by matter passing through them raising them up into prominences one inside the other.

The spiral twists which exist in the tall finger-shaped prominences do not form any insuperable objection to this theory of their eruption, for they may be caused after a very short lapse of time by horizontal vortices existing in the non-incandescent medium into which the prominences are projected.

It may be said that the existence of metallic vapours higher up than they are detected by the spectroscope is by no means improbable, and that because they have ceased to give out monochromatic light it does not follow that they are not there. To this it may be answered, that if such metallic vapours are there, and if they are at the same heat as the intensely incandescent hydrogen which forms the prominences, or, indeed, at the heat of a region of space so near to the photosphere, they would certainly be in a state of vapour; and if in a state of vapour, why not incandescent with their own wave length?

A theory has lately been started that meteors may be formed from the metallic vapours hurled from the Sun or other stars in their eruption prominences.

It appears, however, from the analysis of the Lenarto meteor given by the late Prof. Graham, and quoted by Mr. Proctor in his recent Paper on the "Corona," that the iron of which the meteor was chiefly composed contained at least three volumes of occluded hydrogen, pointing, as Prof. Graham believed, to its formation under great pressure in a dense mass of hydrogen such as we find in the chromosphere. Probably, however, there are no pressures in the chromosphere at all comparable even to atmospheric pressures, we are therefore forced to look to deeper levels (if we look to the Sun at all) as the laboratory where meteoric iron becomes solid, and to believe that the meteors were extruded from the Sun in a solid form* containing the hydrogen they at present hold occluded in them. These considerations taken in conjunction with the remarkable flashes across the chromospheric spectrum observed by Zöllner, Vogel, and Howlett in this country, appear to me to go far to render it probable that solid masses may be hurled from the Sun in eruption prominences.

* On this supposition meteorites would have very high, perhaps infinite, critical temperatures, an assumption surely less improbable than that we are forced to make on the theory that hydrogen is the exploding element, giving rise by its outrush to the prominences, in which case we must assume for it a critical temperature,—at least higher than the minimum solar temperature,—whereas hydrogen has not yet been reduced by pressure to the liquid state even at the lowest terrestrial temperatures. Of the twenty-two meteoric elements given by Miller, there are, however, others besides hydrogen which have not yet been reduced separately.